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Advancing Lead User Methodology in the Fuzzy Front-End of Product Development

Thesis submitted in partial fulfillment of the requirements for the degree of Licentiate of Science (Technology).

Espoo, March 14, 2012

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AALTO UNIVERSITY SCHOOL OF ENGINEERING PO Box 14100, FI-00076 AALTO http://www.aalto.fi	ABSTRACT OF THE LICENTIATE THESIS

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Abstract:

Most companies have come to realize that in order to remain in business, and especially, gain economic success, they need to be able to identify user needs and respond to those needs. The set of activities that takes place before the actual product development, the fuzzy front-end, plays a critical role in the competition of whose products meet user needs the best. The main characteristics of the future product are decided in the front-end, determining much of the rest of the product development process. Thus user needs can have the greatest influence on the product if already recognized in the front-end. Product development is still regarded mainly as the job of designers and engineers in a company. The lead user approach turns the tables and puts users to the center. Lead users face needs months or years before they become general in the marketplace. Lead users are also positioned to benefit significantly, if these needs are met.

The goal of this research is to explore the role of lead users in product development and advance the lead user methodology. Specifically this thesis and the appended publications aim *to further improve the concepts and means available for lead user identification, and to gain more understanding and alternative means for transferring (lead) user knowledge.*

Findings of the thesis include that the challenge of the companies is not only to open up to the possibility that a competitive solution might be developed outside the company, but that it could be developed to meet a need that is identified outside the target market of the product under development. If companies concentrate solely on the needs of the users in the target market, they very possibly miss insights from the lead users.

I show that besides high-performance users, also low-performance users can be seen as lead users. In addition, a product is always part of a net of crossing consummation chains in the user's life, and in user's standpoint it cannot be seen as unconnected. Recognizing the crossing points of different consummation chains and value systems makes it possible to identify in addition to lead users and situational lead users, also positional lead users.

User innovation toolkits have been proposed as a tool to for transferring the need-related (lead) user knowledge to the company. This thesis demonstrates contradictions between the toolkit theory and the optimum content of a toolkit, which leads to the conclusion that creating functional and efficient user innovation toolkits might be too risky a task in most product development cases. I recommend that companies would concentrate on lead user identification. If the lead user has already found a viable solution to his or her need, the solution could be transferred as such. If the lead user is still battling with the unmet need, what is to be transferred is the user need. This can be done through participatory methods, such as the P3D method developed in this thesis.

Date: 14.3.2012	Language: English	Number of pages: 47 + 55

Keywords:	lead users, user innovation, situational lead users, positional lead users, lead user identification, user innovation toolkits

Aalto-yliopisto

AALTO-YLIOPISTO INSINÖÖRITIETEIDEN KORKEAKOULU PL 14100, 00076 AALTO http://www.aalto.fi	LISENSIAATINTUTKIMUKSEN TIIVISTELMÄ

Tekijä:	Pia Helminen	
Työn nimi:	Edelläkäyttäjämetodologian edistäminen tuotekehitysprosessin alkuvaiheessa	
Korkeakoulu:	Insinööritieteiden korkeakoulu	
Laitos:	Koneenrakennustekniikan laitos	
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Tiivistelmä:

Useimmat yritykset ovat todenneet, että pysyäkseen mukana kilpailussa saati siinä menestyäkseen täytyy pystyä tunnistamaan käyttäjien tarpeita ja vastaamaan niihin. Erityisesti tuotekehitysprosessin alkuvaiheissa on mahdollista vaikuttaa siihen, kuinka hyvin käyttäjien tarpeisiin vastaamisessa onnistutaan. Tuotteen tärkeimmistä piirteistä päätetään jo tuotekehitysprosessin alkuvaiheissa, jolloin asetetaan suunta myös prosessin jatkolle. Näin ollen on oleellista tunnistaa käyttäjien tarpeet jo heti prosessin alkuvaiheissa, jotta ne parhaiten voisivat vaikuttaa lopputulokseen. Tuotekehitystä pidetään edelleen pääosin suunnittelijoiden ja insinöörien työnä. Edelläkäyttäjälähestymistapa kääntää asian päälaelleen asettaessaan käyttäjät suunnittelun keskiöön. Edelläkäyttäjät kokevat tarpeita jopa kuukausia tai vuosia ennen kyseisten tarpeitten yleistymistä. Edelläkäyttäjät hyötyvät merkittävästi, mikäli näihin tarpeisiin vastataan.

Tämän tutkimuksen päätavoitteena on tutkia edelläkäyttäjien roolia tuotekehityksessä sekä edistää edelläkäyttäjämetodologiaa. Erityisesti tutkimus ja liitteenä olevat artikkelit tähtäävät edelläkäyttäjien tunnistamisen tapojen ja käsitteiden parantamiseen sekä (edellä)käyttäjätiedon siirtämiseen liittyvien keinojen ymmärtämiseen ja kehittämiseen.

Tutkimuksen löydöksistä: Yritysten haasteena on hyväksyä, että kilpailukykyinen ratkaisu voidaan kehittää yrityksen ulkopuolella mutta myös jopa kohdemarkkinoiden ulkopuolella. Jos yritykset keskittyvät ainoastaan kohdemarkkinoiden käyttäjien tarpeisiin, jäävät mitä luultavimmin edelläkäyttäjien näkemykset huomiotta.

Työssä näytetään, että niin kutsuttujen korkean suorituskyvyn käyttäjien lisäksi myös alemman suorituskyvyn käyttäjät voivat olla edelläkäyttäjiä. Lisäksi tuote liittyy aina osaksi käyttäjän elämässä risteäviä kulutusputkia eikä tuotetta näin ollen voida käsitellä irrallaan käyttäjän elämästä. Kun tunnistetaan eri kulutusputkien risteyskohtia, voidaan tunnistaa myös erilaisia edelläkäyttäjiä.

Käyttäjäinnovaatiotyökalupakkeja on pidetty otollisena välineenä siirtää tarpeisiin liittyvää (edellä)käyttäjätietoa yrityksille. Tässä tutkimuksessa havaitaan ristiriita kirjallisuudessa esitetyn teorian sekä käytännössä optimaalisen työkalupakin välillä. Voidaan päätellä, että toiminnallisen ja tehokkaan käyttäjäinnovaatiotyökalupakin luomiseen yksittäistä tuotekehitysprojektia varten liittyy liikaa riskejä. Suosittelen, että yritykset keskittyisivät edelläkäyttäjien tunnistamiseen. Jos edelläkäyttäjä on jo kehittänyt tarpeeseensa ratkaisun, voitaisiin itse ratkaisu siirtää yritykselle. Jos edelläkäyttäjällä ei ole vielä ratkaisua tarpeeseensa, voitaisiin siirtää tarve käyttäjiä osallistavien menetelmien, kuten tässä tutkimuksessa kehitetyn P3D:n, avulla.

Päivämäärä: 14.3.2012	Kieli: englanti	Sivumäärä: 47 + 55

Avainsanat: edelläkäyttäjät, käyttäjäinnovaatiot, käyttäjäinnovaatiotyökalupakit

Acknowledgements

During the years of my research, now pulled together in this thesis, I have crossed paths with many individuals that have somehow contributed to my work. They have given me ideas, smart comments, constructive criticism, or helped me navigate to the right direction, if my thoughts have been going round in circles (and they have).

First of all, I would like to express my gratitude to Professor Kalevi Ekman for introducing me to the world of product development, and for his encouragement during my postgraduate studies. Many past and present colleagues in the Department of Engineering Design and Production, BIT Research Centre, and Design Factory have given me vital support research-wise, but often even more importantly, they have made the work fun.

I would like to thank my co-authors Katja, Anssi, Matti, Samuli, and Juha. It has been a pleasure working with you. Special thanks go to my colleagues Miko, Tua, and Matti, who took their time to comment the draft of the thesis.

I am grateful to my instructor Sampsa Hyysalo for his valuable academic insights, and I am eagerly looking forward to our joint research projects.

Doing research, writing the appended articles, and compiling the thesis would not have been possible without funding. I would like to thank the Finnish Funding Agency for Technology and Innovation (Tekes), the Finnish Broadcasting Company YLE, and Aalto Service Factory thematic group “Service design with and for citizens”.

Last but not least, I want to thank my dear family, Riksu and Saima, for putting up with me. :)

This licentiate’s thesis is only a stopover on a longer journey. Stay tuned.

Helsinki, December 20, 2010

Pia Helminen

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Nomenclature

FFE	Fuzzy front-end
LU	Lead User
P3D	Participatory 3D modeling
PLU	Positional Lead User
R&D	Research and development
SLU	Situational Lead User

List of Publications

I. Hannukainen, P. and Hölttä-Otto, K. (2006) Identifying Customer Needs – Disabled Persons as Lead Users. In Proceedings of ASME 2006 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference, IDETC/CIE 2006, 10–13 September 2006, Philadelphia, PA, USA.

II. Helminen, P. (2008) Disabled Persons as Lead Users for Silver Market Customers. In Kohlbacher & Herstatt (Eds) The Silver Market Phenomenon: Business Opportunities in an Era of Demographic Change. pp. 85–102. Springer.

Revised version published also in the 2nd revised edition of the book:
Helminen, P. (2010) Disabled Persons as Lead Users for Silver Market Customers. In Kohlbacher & Herstatt (Eds) The Silver Market Phenomenon: Marketing and Innovation in the Aging Society. pp. 27–44. Springer.

III. Tuulenmäki, A. and Helminen, P. (2009) Lead Users of Positional Value. In Proceedings of 8th European Academy Of Design Conference, 1–3 April 2009, The Robert Gordon University, Aberdeen, Scotland.

IV. Helminen, P., Hämäläinen, M. M. and Mäkinen, S. (2010) Redefining User Perception – A Method for Fully Capturing the User Perspective of a Product Concept. In Proceedings of the ASME 2010 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference, IDETC/CIE 2010, 15–18 August 2010, Montreal, Quebec, Canada.

V. Helminen, P. and Ainoa, J. (2009) User Innovation Toolkits in Product Development: Qualitative Study in Shopping Center Design. In Proceedings of International Conference on Engineering Design, ICED'09, 24–27 August 2009, Stanford University, Stanford, CA, USA.

Additional publications not included in the thesis:

Hölttä-Otto, K., Helminen, P., Ekman, K. and Roemer, T. (2007) A pilot program teaching dispersed product development in collaboration with an international university. In Proceedings of ASEE Annual Conference. June 24–27, Honolulu, HI, USA.

Tuulenmäki, A. and Helminen, P. (2009) Att hitta "lead users" – eller pilotanvändare. Design Research Journal (2), SVID Stiftelsen Svensk Industridesign.

Author's Contribution

Publication I: The author was responsible for the original research idea and research design. Collecting and analyzing the data was done by the author. Katja Hölttä-Otto helped with interpreting the results and writing the article. The author presented the work in IDETC/CIE 2006 conference.

Publication II: The author is solely responsible for conducting the research and writing the article.

Publication III: This work was done in co-operation with Anssi Tuulenmäki. Tuulenmäki and the author co-designed the original idea and co-wrote the article. Tuulenmäki finalized the article and presented the work in the 8th European Academy Of Design Conference.

Publication IV: This work (including the original idea, research design, data collection and analysis) was done in co-operation with Matti M. Hämäläinen and Samuli Mäkinen. The author was for the most part responsible for writing the article. Hämäläinen presented the work in IDETC/CIE 2010 conference.

Publication V: The original idea was developed and the experiment was designed in co-operation with Juha Ainoa. Ainoa was responsible for conducting the experiment. Data analysis and writing the initial draft was done in co-operation. The author was responsible for refining and finalizing the article. Ainoa presented the work in ICED'09 conference.

1 Introduction

1.1 Background

Most companies have come to realize that in order to remain in business, and especially, gain economic success, they need to be able to identify user needs and respond to those needs. The set of activities that takes place before the actual product development, the fuzzy front-end, plays a critical role in the competition of whose products meet user needs the best. The main characteristics of the future product are decided in the front-end, determining much of the rest of the product development process. Thus user needs can have the greatest influence on the product if already recognized in the front-end.

The key questions that all product development projects face in this regard are: How are user needs identified? And are these the needs of the right users? Although many companies claim to be user-oriented, there is room for improvement. 10–40 % of users modify products (cf. Lüthje & Herstatt 2004), as the products do not meet the needs these users experience. Users are forced to innovate, since companies are not able to develop products that would satisfy the needs of their potential customers.

Product development is still regarded mainly as the job of designers and engineers in a company. The lead user approach turns the tables and puts users to the center. This thesis explores the role of lead users in product development.

1.2 Scope and Objectives

The focus of this thesis is on users, particularly lead users. Although the studies presented in the appended publications are related to completely different products and contexts – mobile phone use, online resource portal for teachers, and shopping center design – all five publications discuss the role of users in product design and development.

The goal of this research is *to explore the role of lead users in product development and advance the lead user methodology*. Specifically this thesis and the appended publications aim

(A) *to further improve the concepts and means available for lead user identification*, and

(B) *to gain more understanding and alternative means for transferring (lead) user knowledge*.

1.3 Research Methods

Publications I, **II**, **IV** and **V** are grounded in empirical data. **Publication III** is based on observations and examples. All publications are also based on literature reviews. Photo diaries, contextual inquiry and semi-structured interviewing were used in **Publications I** and **II**. **Publications IV** and **V** draw from experimental setups especially designed for these studies, but also semi-structured interviews were carried out. All research methods and corresponding publications are compiled in Table 1.

Table 1 Applied research methods

APPLIED RESEARCH METHODS	I	II	III	IV	V
Literature review	x	x	x	x	x
Semi-structured interviews	x	x		x	x
Contextual inquiry	x	x			
Photo diary	x	x			
Experimental setups				x	x

1.4 Outline of the Thesis

This thesis consists of two main parts. The first part is the theoretical foundation that also forms the frame of reference for the thesis. It consists of six elements:

- Product development
- User innovation
- Lead users
- Lead user method and identification
- User innovation toolkits
- Positioning of the thesis

These elements are discussed in Chapter 2, the frame of reference.

The second part of the thesis is formed of the appended publications (see Appendices). **Publication I** has its focus on how extraordinary users can be seen as lead users for mainstream markets. **Publication II** shows how disabled persons can be lead users particularly for so called silver market customers. **Publication III** introduces two concepts – situational and positional lead users – and presents a framework that makes it easier to find lead users. **Publication IV** introduces a method for illustrating the differences of user and designer perspectives. **Publication V** examines the roles of solution space and module library have in user innovation toolkits. Figure 1 outlines the structure of the thesis.

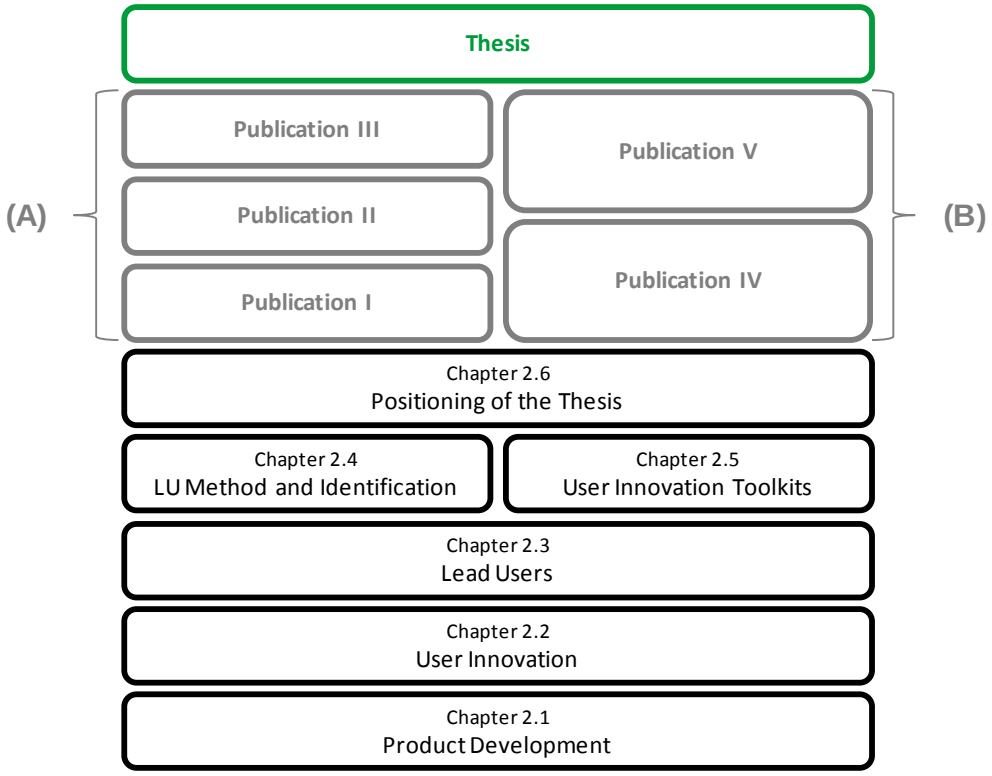

Figure 1 Positioning of the frame of reference, appended publications, and objectives *(A) to further improve the concepts and means available for lead user identification*, and *(B) to gain more understanding and alternative means for transferring (lead) user knowledge*

2 Frame of Reference

In the following, the theoretical foundation of this thesis is presented. Concepts of product development, user innovation, lead users, lead user method and identification, and user innovation toolkits are examined in detail. Lastly, the positioning of the thesis regarding the theoretical foundation is presented.

2.1 Product Development

According to Ulrich and Eppinger (2008), a product is something that is sold by an enterprise to its customers. Before being able to sell and deliver products, they first have to be designed and manufactured. Product development should be then understood as all the activities beginning with the perception of a market opportunity and ending in the production, sale and delivery of a product (see Figure 2).

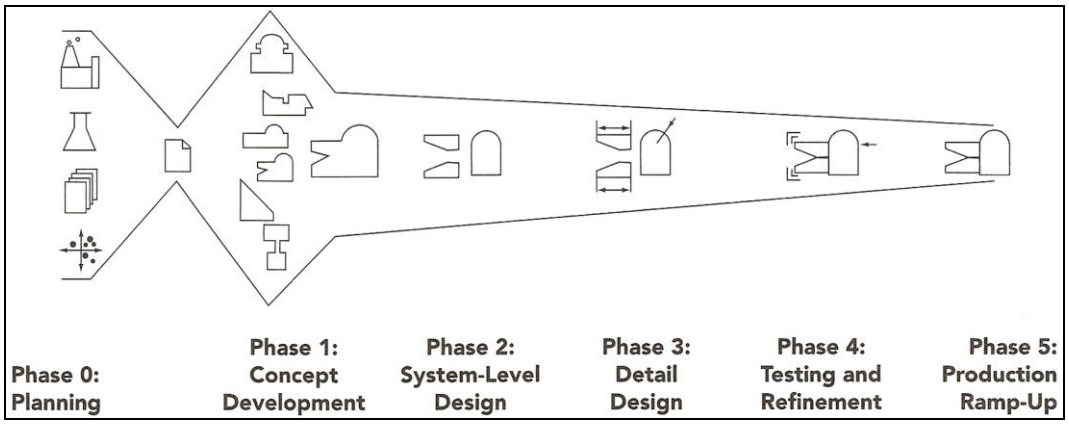

Figure 2 Product development process (Ulrich & Eppinger 2008)

Otto and Wood (2001) examine product development on a process level – product development process, design process, manufacturing process, and research and development (R&D) – where the design process is seen as an internal process within product development:

The *product development process* is the set of activities that includes everything from the initial inspiring new product vision, to business case analysis activities, marketing efforts, technical engineering design activities, development of manufacturing plans, and the validation of the product design to conform to these plans. Often it even includes development of the distribution channels for strategically marketing and introducing the new product.

The *design process* is the set of technical activities within a product development process that works to meet the marketing and business case vision. It includes refinement of the product vision into technical specifications, new concept development, and embodiment engineering of the new product.

The *manufacturing process* follows the product development process, although the design of the manufacturing process is generally considered part of the product development process. If the product design process and the design of its manufacturing system are carried out simultaneously we talk about concurrent engineering. (Otto & Wood 2001) The term concurrent engineering is also used, when different design activities are carried out concurrently. (Ketola 2002)

The *research and development* phase of new product development is when new technology is developed for subsequent incorporation into products. Nowadays many companies try to separate the R&D process from the product development process. This means that new technology is developed by R&D teams to the point where the technology is encapsulated into a new system and is then ready for immediate adoption by the product development teams. This arrangement is similar to out-sourced subsystems and ideally makes product development a very rapid process where technologies are tailored into new systems that meet changing market needs. In the real world the transfer from R&D to product development is not necessarily smooth. The technology passed on to the product development teams may not function well in the new product concept. This may result from social causes, such as different cultures between R&D corporate research and product development business units, or from the fact that the new technology is used in ways not foreseen by the R&D group. One general problem is also miscommunication of specifications.

The set of activities preliminary to the actual product development is often called the *fuzzy front-end* (Koen et al. 2001; Khurana & Rosenthal 1998; P. G. Smith & Reinertsen 1991). This includes the decisions on what products to consider for development. These decisions derive from the determination of what technologies are to be used and in which markets a company should compete. Forecasted customer markets and business trends can impact these decisions. The fuzzy front-end also includes development decisions on what the underlying portfolio architecture should be for set of products that may be offered by a company.

Common to the views of Ulrich and Eppinger, and those of Otto and Wood – and other traditional views – is that product development is carried out inside the company by designers and engineers who work for that particular company. To be able to identify a potential market opportunity, designers should understand what customers of that market, i.e. users of the product under development, truly need. Understanding users can be, however, difficult. In fact it is one of the areas of most persistent and costly failure in product development

(Hyysalo 2009, p 13; Hyysalo 2010, p xxiv). One of the pertinent reasons is, as we suggest in **Publication IV** (Helminen et al. 2010) of this thesis, the designer's view on a product or service being very different from the one of the user's (see Figure 3).

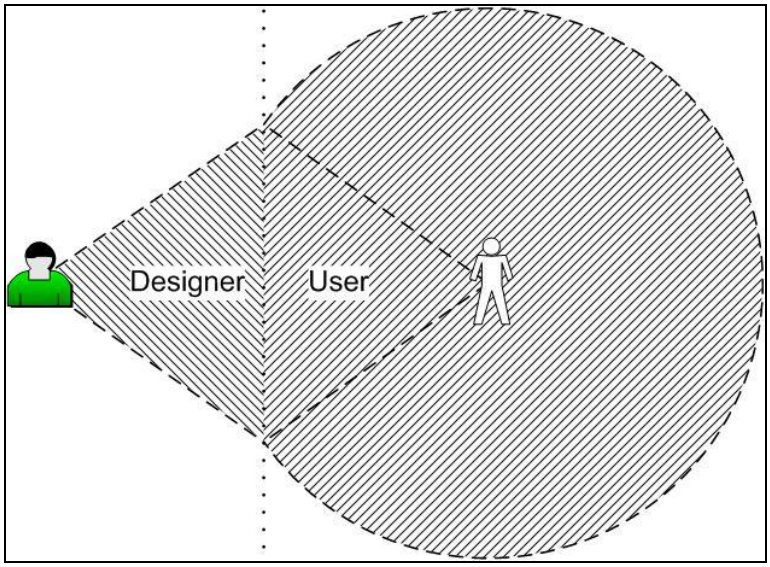

Figure 3 Designer's perception versus the user's perception of the product concept, Publication IV (Helminen et al. 2010)

Regardless of the amount of efforts made in the company, the fact is that users always see the world from another perspective, having a full understanding of the purpose of the use, the use context, and other elements defining the particular use situation. Therefore they often end up innovating themselves when not satisfied with the current offering in the market.

2.2 User Innovation

> *"In the first fire-engines, a boy was constantly employed to open and shut alternately the communication between the boiler and the cylinder, according as the piston either ascended or descended. One of those boys, who loved to play with his companions, observed that, by tying a string from the handle of the valve which opened this communication to another part of the machine, the valve would open and shut without his assistance, and leave him at liberty to divert himself with his playfellows. One of the greatest improvements that has been made upon this machine, since it was first invented, was in this manner the discovery of a boy who wanted to save his own labour."* (Smith 1776, pp. 24–25)

Traditionally companies have relied on internal innovation that is based on the assumption that successful innovation requires control. Companies generate

their own ideas and then develop them, build them, market them, distribute them, service them, finance them, and support them on their own. Chesbrough (2003) calls this *closed innovation* and claims that it makes companies run in circles: Companies invest in internal R&D, make discoveries that enable the company to bring new products and services to market, realize more sales and higher margins, and then in order to improve the products and services, the company needs to re-invest more in internal R&D.

The concept of *open innovation* is a paradigm that assumes that in addition to internal ideas, companies can and should use external ideas and external paths to the market, in order to advance their technology and products. This includes buying or licensing knowledge, processes, or inventions (i.e. patents) from outside. It should also work the other way around: Internal inventions not being used in a company's business should be taken outside the company through licensing, joint ventures, or spin-offs. (Chesbrough 2003; Chesbrough et al. 2006)

While Open Innovation is a broad term comprising of all forms of external innovation, *user innovation* means innovation carried out specifically by users. Users are individual consumers or companies that expect to benefit from using a product or a service, where as manufactures expect to benefit from selling a product or a service (von Hippel 2005). Traditionally users have been seen as passive consumers who merely consume the products that manufacturers develop. In reality, users have always been making modifications to products when needed. In fact, when users need something badly and there is no solution on the market, they will generate a solution by themselves – they will innovate. One of the earliest examples of user innovations was given by Adam Smith in 1776, quoted in the beginning of this chapter, and since then examples have amassed in numerous fields, from library information search systems to mountain bikes. The examples show that the fraction of users creating innovations among all users in the field varies from 10 % to as high as 40 %
(Urban & von Hippel 1988; Morrison et al. 2000; Lüthje 2003; Franke & Shah 2003; Franke & von Hippel 2003; Lüthje 2004; Lüthje et al. 2005).

Often, user innovation is confused with user-centered design. Even though some of their methods and aims share similarities, there are many important differences. The roots of user-centered design are in the military industry. In World War II it was found that the performance of technology can be improved if attention is paid to the ergonomic requirements of those who use the technology. The goal of user-centered design is to transfer user needs into product specifications, and thus ensure the satisfaction of the future customers. What is characteristic of user-centered design methods is that it is still the designer at the R&D organization who takes the centre stage. Users provide the designer with information and ideas for solutions that he or she can use when designing the product. This is in contrast to user innovation, where it is the *user* that innovates with or without the designer.

The user-centered design approaches offer a variety of methods for user needs assessment: interviewing (group, open, structural, etc.), contextual inquiry (Beyer & Holtzblatt 1998; Beyer & Holtzblatt 1999), probing (Gaver et al. 1999), observing, etc. All of these methods help the designer learn about the needs of the targeted user. Thus, the company first learns about user's needs and then develops a corresponding product to meet that need. Even if the user has developed some type of solution to his/her need, companies very often overlook user's solution, registering only the need. The main difference between user innovation and user-centered design is thus who carries out the actual innovation. In user-centered design the innovator is predominantly still the *designer* who works in a company.

In the zone between user innovation and user-centered design reside many *participatory design* methods. Participatory design aims to conduct design *with* users, facilitating innovative activities *by* the users, but also including elements where designers develop solutions *for* the users (Voss et al. 2009; Bødker et al. 2004). However, participatory design typically depends, as the name suggest, on design collaboration between designers and users and in this regard differs from 'pure' user innovation. Moreover, as we come to discuss later, product development approaches that build on user innovation and users who are most likely to innovate, differ considerably from the ideals of democratic and representative participation that characterize participatory design (Voss et al. 2009; Hyysalo 2010). The lead user methodology (see Chapters 2.3 and 2.4) is interested only in the quality of the innovation and innovative ideas that can be built (Churchill et al. 2009).

Users innovate because they have to. What is interesting about user innovation is that the designer of the solution – the user – benefits directly from the innovation. This is not the case when a company develops the solution. Users do not care how the need is met, as long as it is met. Companies, on the other hand, need to struggle with many things other than the optimal solution: product portfolios, strategy, manufacturing capability, etc. Users can come up with the most creative solution, because they are searching for the best possible *functional* solution to their own problem.

The terms mass customization, personalization, and tuning relate intimately to user needs. Äijälä (2007) categorizes these terms as follows: The goal of *mass customization* is to design, manufacture, market and deliver reasonably priced products that satisfy individual user needs. Cars, for example, are mass customized, i.e. the buyer gets to choose from a large variety of alternatives such as colors, materials and accessories. *Personalization* also aims at satisfying user needs, but unlike in mass customization, the company only gives the user tools to modify the product according to his/her personal needs. The company approves and enables personalization, but the user carries it out. At one point,

mobile phone manufacturers offered interchangeable covers for phones, so that the user was able to modify the appearance of the phone to his or her liking. *Tuning* is product modification done completely by the user. The company plays no role in tuning, whereas in personalization, the user does modify the product, but the modification process is designed at the company. Therefore only tuning can be classified as user innovation. Car-tinkerers make a classic example of users who tune products.

To better grasp the concept of user innovation, von Hippel (1986) developed the term Lead User that is introduced next.

2.3 Lead Users

There was a time when nobody needed a mobile phone. At least nobody had one. Now almost everyone has one (or several), and some claim it would be impossible to live without one. In 1990 only 5 % of Finns had a mobile phone, in 1998 already 55 %, and by the end of 2008 the rate was 130 %, that is on average 1.3 phones per person (Tilastokeskus 2009). Today there is a clear need for a mobile phone. But what will the market need tomorrow? How can we learn about a new market when the market does not yet exist? The answer is Lead Users.

Rogers (1962; 1995) talks about the diffusion of new ideas through a society, and the fact that a considerable time lag exists from the introduction of a new idea to its widespread adoption. The main elements in the diffusion of new ideas are: (1) an innovation (2) that is communicated through certain channels, (3) over time (4) among the members of a social system. In spite of the fact that the communication of most innovations involves a time lag, there is certain inevitability in their diffusion. Most attempts to prevent innovation diffusion over an extended period of time have failed. For instance, the Chinese were unsuccessful in their attempt to maintain their position as the only knowledge of gunpowder. And today, the secret of the nuclear bomb is no longer a secret. (Rogers 1962; Rogers & Shoemaker 1971; Rogers 1995)

According to the diffusion model, an innovation is completely diffused when it has been adopted by 100 % of the members of the social system to which it has been introduced. Rogers (1995) divides the adopters into five categories: innovators, early adopters, early majority, late majority, and laggards. When a large amount of data is arranged on a symmetric bell curve, the shares of these five categories are roughly as follows:

- *Innovators*: the first 2.5 % who adopt a new technology. They are "venturesome" almost to the point of obsession, and willing to absorb

high costs and uncertainties for the reward of being first to adopt new technologies.

- *Early adopters*: the next 13.5 % to adopt. They find it easy to imagine, understand, and appreciate the benefits of a new technology. By many they are considered as "the individual to check with" before using a new idea. The highest number of "opinion leaders" is found among the early adopters.
- *Early majority*: the next 34 % to adopt. They adopt new ideas just before the average member of a system. They follow with deliberate willingness in adopting innovations, but seldom lead.
- *Late majority*: the next 34 % to adopt. They are skeptical about innovations and often adopt only because of the peer pressure those who have already adopted. They often have relatively scarce resources, which means that most of the uncertainty must be removed before they feel safe to adopt.
- *Laggards*: the final 16 % to adopt. They are traditionalists and tend to be suspicious of innovations. They possess almost no opinion leadership. The point of reference for the laggard is the past.

It must be remembered than no-one has an absolute status of belonging to any of these categories. The same person can be an early adopter regarding a certain product, but a laggard regarding something else. (Hyysalo 2009, p 98)

The theory of lead users relies on the idea that there is always somebody who has the need first, and that the rest of the marketplace will have the need later. There are always users whose present needs foreshadow general demand (Rogers & Shoemaker 1971). Von Hippel (1986) introduced the term *lead user* in 1986. He defines lead users of a novel or enhanced product, process, or service as those displaying two characteristics with respect to it:

1. Lead users face needs that will be general in a marketplace – but face them months or years before the bulk of that marketplace encounters them, and
2. Lead users are positioned to benefit significantly by obtaining a solution to those needs.

According to the first lead user characteristic, the "ahead of an important market trend" variable, there are users who experience new needs and are prepared to generate innovations that substantially differ from existing market offers. The second characteristic, the "expected benefits" variable reflects the possibility of the users initiating the development of a new solution if the solution would bring them significant benefit (von Hippel 1988; von Hippel 2005). In other words, lead users are well ahead of market trends and have needs that go far beyond those of the average user (von Hippel et al. 1999).

It is important to distinguish lead users from the categories defined by Rogers (1995). A lead user acts solely on his or her needs, while innovators and early adopters are driven by their interest in the new technology. In other words, as stated by von Hippel (2007, p 300): "Note that lead users are not the same as early adopters of an innovation. They are typically ahead of the entire adoption curve in that they experience needs before any responsive commercial products exist – and therefore often develop their own solutions." See Figure 4.

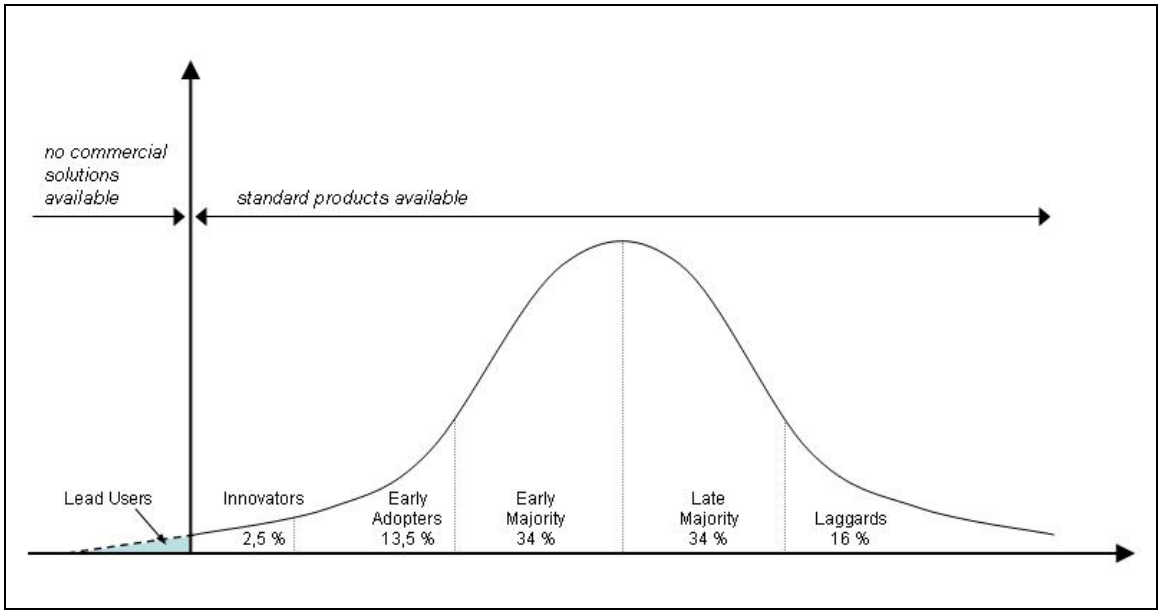

Figure 4 Lead users' position on a market trend compared to Rogers's diffusion curve [author's depiction based on von Hippel (2005) and Rogers (1995), Publication II (Helminen 2008)]

Classical research on problem-solving shows an interesting fact: Problem solving may be inhibited by the functional fixedness of solution objects (Duncker 1945). This means that if we examine users that are already familiar with the product, we might find them not to be able to generate new ideas for its use. They are functionally fixed and therefore unable to think out of the box. Duncker's example was a chimpanzee using a stick: "A stick that has just been used as a ruler is less likely to appear as a tool for other purposes than it would normally be." But an equally good example can be found in anybody's toolbox: A screwdriver is designed for handling screws but as it is long and sharp, it could also be used as a crowbar or a chisel. Or if a person is asked to perform a task that requires the use of a wire, he or she is less likely to un-bend a paper clip if the clip is given attached to papers than if it is seen loose (Adamson 1952).

When companies try to be customer-oriented, they usually look at the targeted customers. The problem with the customers of the target market is that they tend to be relatively functionally fixed (Duncker 1945), and have less elaborated needs understanding due to existing tools that suite them "well enough" so that they have not needed to question how these tools could be improved

(Hyysalo 2010, chapters 4 and 8). Most customers are therefore unable to reveal information that enables the company to create breakthroughs. Lack of functional fixedness makes lead users very appealing to product development – lead users do not base their views on existing products but on their needs. “In contrast, lead users would seem to be better situated in this regard – they ‘live in the future’ relative to representative target-market users, experiencing today what representative users will experience months or years later.” (Lilien et al. 2002, p 1044)

Who are lead users then? A lead user is often somebody who is trying to improve his or her way of working rather than consciously trying to invent. Like the developer of the World Wide Web Tim Berners-Lee says: “It was something I needed in my work” (Brody 1996). Berners-Lee wanted simply to solve a problem that was hindering his efforts as a consulting software engineer at CERN, the European Organization for Nuclear Research in Geneva. Mainly to become more efficient, he developed a system that provided easy-to-follow links between documents stored on a number of different computer systems and created by different groups. He expanded the idea he had developed at CERN and made it available on the Internet in the summer of 1991. (Brody 1996)

Sporting equipment is an area where innovations are often developed by lead users. Shah (2000) shows that innovations in skateboarding, snowboarding, and windsurfing have typically been developed by a few early expert participants in those sports. The innovating users are in their teens or early twenties and technically unsophisticated. They develop their innovations via learning-by-doing in these novel and rapidly evolving fields. This is the key here: to literally stay or go ahead in the game they must seek to invent.

Another sports related lead user originated example is that of a heart rate monitor. The idea for the heart rate monitor was originated by professor Seppo Säynäjäkangas already in early 1970’s. He enjoyed cross-country skiing, and he started wondering what methods could be used to monitor the development of his condition. Suomen Hiihtoliitto (Finnish Ski Association) soon became interested in the idea and started developing a prototype with professor Säynäjäkangas. Later this invention has been utilized by all competitive athletes, and nowadays the heart rate monitor has been diffused to serve a big part of people who enjoy recreational sports.

The energy bar was invented by Olympic marathoner Brian Maxwell. He conceived of the idea of an endurance-boosting bar for athletes after “bonking” (what runners call the point at which the body runs out of carbohydrates and starts burning muscle) in a 1983 race. Working with his girlfriend Jennifer, a nutritionist, the pair came up with an energy bar that athletes could eat before and during events. In 1986, they began making PowerBars in their kitchen.

In addition to athletics, examples of lead user innovation can also be found in abundance in other harsh conditions, such as aerospace and military solutions. However, cases can be found virtually in any field. For example, when 3M, a diversified technology company, was trying to develop cheaper and more effective infection control in the area of surgical drapes[1], they went to gather information outside the target market, in order to find lead users. They traveled to hospitals in Malaysia, Indonesia, South Korea, and India, and learned how people in less than ideal environments attempt to keep infections from spreading in the operating room. They interviewed veterinarians who had great success keeping infection rates low despite cost constraints and the fact that their patients were covered with hair and didn't bathe. They also interviewed Hollywood makeup artists who had learned effective ways to apply non-irritating, easy-to-remove materials to skin – which is important to the design of infection control materials. With the help of lead users, 3M was able to create three new product-line concepts. (von Hippel et al. 1999)

It is to be noticed that lead users are not necessarily just individual consumers; they can also be large companies. For example, if an airplane manufacturer develops a tool to help build airplanes, it has developed an innovation as a user. In contrast, when it develops an innovative new aircraft to manufacture and sell, the innovation is classified as a manufacturer innovation. (von Hippel et al. 1999)

When trying to identify a lead user, it should be remembered that lead users can also be found from a totally different branch of industry than the one of the possible application. If a manufacturer of materials used in automobiles identifies a trend toward lighter, higher strength materials, the company may find the lead users at the front of this trend are aerospace firms rather than auto firms, because aerospace firms may be willing to pay more than auto firms for improvements of these attributes. (von Hippel 1986) Veterinarians in contrast to physicians of human patients, or aerospace industry in contrast to automobiles are called *advanced analogous fields*. These are markets that face similar problems but perhaps in a more extreme form.

If an automobile manufacturer aimed to design an innovative braking system, it might start by trying to find out if any innovations had been developed by drivers with a strong need for better brakes, such as auto racers. Next, it would look to a related but technologically advanced field where people had an even higher need to stop quickly, such as aerospace. And, in fact, aerospace is where innovations such as antilock braking systems (ABS) were first developed: military

[1] Surgical drapes are thin adhesive-backed plastic films that are adhered to a patient's skin at the site of surgical incision, prior to surgery. Surgeons cut directly through these films during an operation.

aircraft commands have a very high incentive to stop their vehicles before running out of runway. (von Hippel et al. 1999)

Often lead users solve their problems by utilizing existing commercial products in ways not anticipated by their manufacturers (von Hippel 1986). In the case of the ABS, had the automobile manufacturer actually looked at the users of the leading edge – the auto racing teams – they would have noticed that race car drivers had learned to manually pump their brakes and the automobile manufacturer would not have had to go to aerospace industry in the first place (von Hippel 2005).

There are many examples of so called *high-performance users* being lead users: marathon runners vs. casual joggers, aerospace vs. car industry, etc. In **Publication I** (Hannukainen & Hölttä-Otto 2006) and **Publication II** (Helminen 2008), it is shown that also *low-performance users* can be lead users. In the study of mobile phones, the user needs of disabled users and those of situationally disabled users were compared. Situational disability means a situation where an able-bodied user is not able to perform "normally" but the use of his or her senses or limbs is hindered: when driving a car, when there is no light, and when there is noise, for example. It is shown that user needs of situationally disabled users overlap with the needs of disabled users. There are also several examples of leading edge behavior of disabled users (i.e. the ahead of a market trend component), and it is concluded that disabled users can be seen as lead users when developing products for the large market of able-bodied users.

As lead users' present strong need is likely to become general in a marketplace, but it will take months or even years for that to happen, lead users can be used as a need-forecasting laboratory for marketing research. In addition to the need data, they can provide valuable new product concept and design data, because of their attempt to fill the need they experience. (von Hippel 1988) Developing products to meet these needs that are still latent for the majority of the market allows a company to anticipate trends and to leapfrog competitive products. Analysis of data from lead users can improve the productivity of new product development in fields characterized by rapid change (von Hippel 1986).

In their study on kite surfing, Franke et al. (2006) analyze the relationship between the commercial attractiveness of innovations developed by users and the intensity of the lead user characteristics embodied in those users. It is illustrated in Figure 5 that when moving from low to high in the expected variable (LU component 1), the proportion of innovating users rises. Similarly, when moving towards the position in ahead of a trend (LU component 2), the attractiveness of innovations rises. They also found out that a single component of the lead user definition – being at the leading edge of a marketplace trend – predicts both user innovation likelihood and innovation attractiveness.

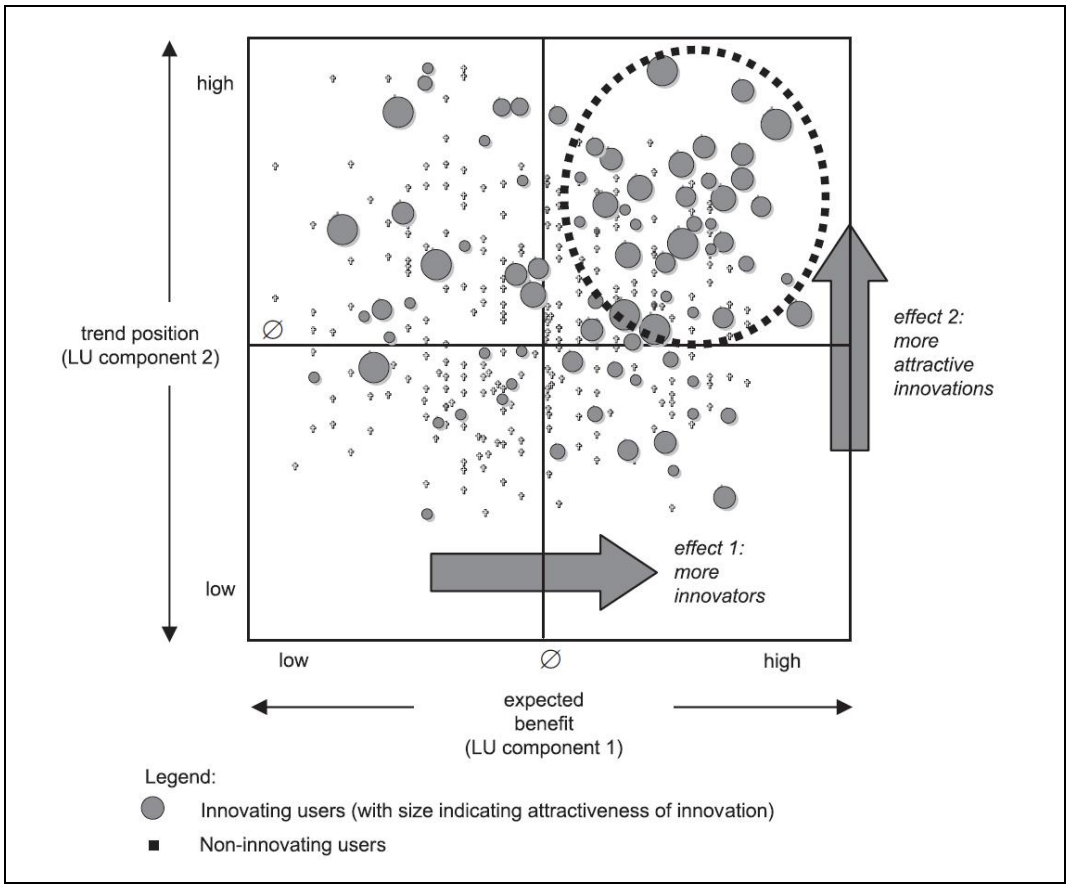

Figure 5 The effect of the lead user characteristics on the attractiveness of lead user innovations (Franke et al. 2006)

Lead users are "the ultimate users" to find, in order to benefit from the innovation potential of users. Next, literature is explored focusing on processes of how lead users can be utilized in product development projects, and also how lead users can be identified.

2.4 Lead User Method and Identification

When von Hippel first introduced the term lead user in 1986, he also suggested a four-step process on how these lead users should be utilized: 1) Identify an important market or technical trend; 2) Identify lead user who lead that trend in terms of a) experience and b) intensity of need; 3) Analyze lead user need data; 4) Project lead user data onto the general market of interest. (von Hippel 1986)

In 1988 Urban and von Hippel (1988) introduced a more general methodology for concept development and testing consisting of the following four steps:

1. *Specify lead user indicators*

   A. *Find market or technological trend and related measures*

Lead users are defined as being in advance of the market with respect to a given important dimension which is changing over time. Therefore, before one can identify lead users in a given product category of interest, one must specify the underlying trend on which these users have a leading position, and must specify reliable measures of that trend.

   B. *Define measures of potential benefit*

High expected benefit from solving a need is the second indicator of a lead user, and measures or proxy measures of this variable must also be defined. In work to date, we have found three types of proxy measures to be useful. First, evidence of user product development or product modification can serve as a proxy for user benefit because, as we noted previously, user investment in innovation and user expectations of related benefit have been found to be correlated. Second, user dissatisfaction with existing products (services and processes) can serve as a proxy for expected benefit because it is logical that the degree of dissatisfaction with what exists will be correlated with the degree of expected benefit obtainable from improvements. Finally, speed of adoption of innovations may also serve as a surrogate for high expected benefit. Early adoption and innovativeness have been found often correlated with the adopter's perception of related benefit (Rogers & Shoemaker 1971).

2. *Identify lead user group*

Once trend and benefit indicators are specified, one may screen the potential market based on the measures specified above via questionnaire and identify a lead user group. This is accomplished by a cluster analysis of the survey-based lead user indicators to find a subgroup which is the leading edge of the trend being studied and displays correlates of high expected benefit from solutions to related needs.

3. *Generate concept (product) with lead users*

The next step in the method involves deriving data from lead users related to their real-life experience with novel attributes and/or product concepts of commercial interest. This experience may include modifications to existing products or new products which they have created to meet their needs. Creative group sessions can be used to pool user solution content and develop a new product concept. In some cases the user solution may represent not only a concept but a fully implemented product.

4. Test lead user concept (product)

The needs of today's lead users are typically not precisely the same as the need of the users who will make up a major share of tomorrow's predicted market. Indeed, the literature on diffusion suggests that, in general, the early adopters of a novel product or practice differ in significant ways from the bulk of the users who follow them (Rogers 1962). One therefore next assesses how lead user data are evaluated by the more typical users in the target market. This can be done by employing traditional concept (product) test procedures after segmenting lead and non-lead user responses.

Later on, also Lüthje and Herstatt (2004) and Churchill et al. (2009) have presented versions of the lead user method. Both processes are essentially similar to the one of Urban and von Hippel. The four-step process of Lüthje and Herstatt is illustrated in Figure 6. The steps of Churchill et al. include: 1. Preparing for your lead user project, 2. Identifying trends and key customer needs, 3. Understanding the needs and solutions of lead users, and 4. Improving solution concepts with lead users and experts.

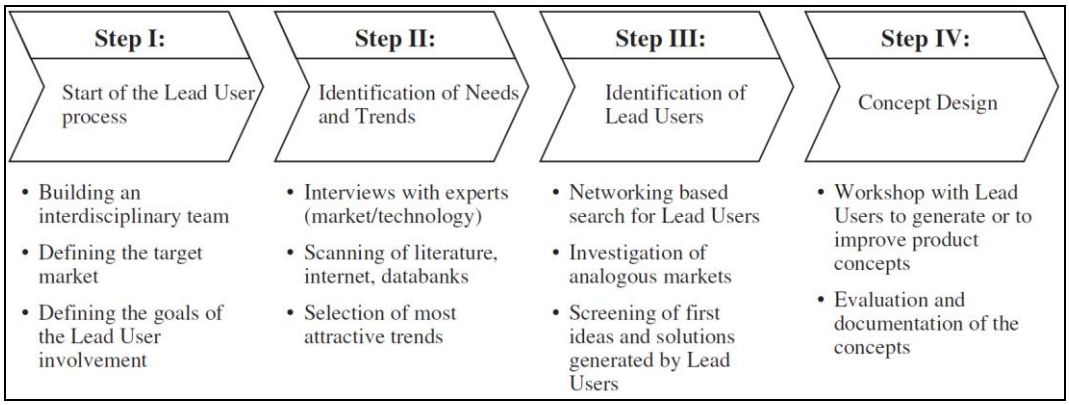

Figure 6 The process of the lead user method (Lüthje & Herstatt 2004)

Although the lead user method seems quite straightforward, there is one bottleneck: *How* are the lead users identified? Literature suggests methods such as screening, broadcasting and networking based searches like snowballing and its variant pyramiding.

Mass *screening* is based on collecting information from every member of a population or sample to identify the members with desired attributes. The problem is that as lead user characteristics are not very common, a large number of people must be screened in order to find a sufficient number of lead users. As Sudman (1985) puts it: "If the population [with desired attributes like lead user characteristics] is rare or very rare, screening costs may be very large and account for the major share of data collection costs." Efficiency of screening becomes clear in the study of Lüthje (2000), for example. He reports

screening 2043 persons to identify 22 lead users in a lead user study – a sampling efficiency of only 1.1 %.

Snowballing, on the other hand, is premised on the assumption that people in any population tend to personally know others similar to themselves. Snowball sampling means that individuals with a desired characteristic are asked to identify people who have the same characteristic (Goodman 1961; Welch 1975), or more broadly, people who can provide important information on the issue that is being investigated.

Pyramiding search is a variant of snowballing. What distinguishes pyramiding from snowballing is that individuals are asked to identify people who have more of the same desired attribute i.e. pyramiding enables "moving up the pyramid" rather than staying at the same level (von Hippel et al. 1999). Pyramiding also applies a serial search for a solution where learning from each experiment is incorporated into the next in the series (Thomke et al., 1998). Through pyramiding, by following the chain of referrals, one can also network the way to an advanced analogous field (von Hippel et al. 2009). The difference between screening and pyramiding is illustrated in Figure 7.

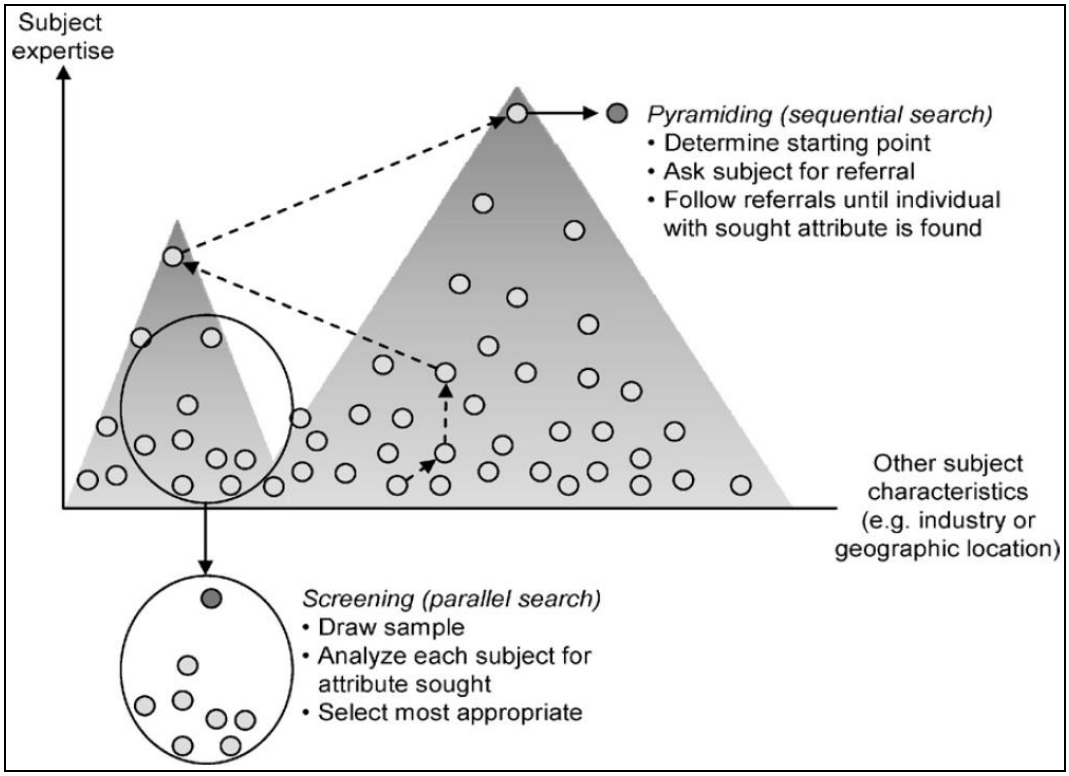

Figure 7 The search concepts of screening and pyramiding (von Hippel et al. 2009)

Broadcasting, or broadcast search, involves broadcasting the need for a solution and this way transforming the problem solver into a solution seeker. Individuals with potential solutions hear the message and self-select whether they respond

to the broadcast or not. (Lakhani 2006; Jeppesen & Lakhani 2010) A problem can be broadcasted on an Internet discussion forum of a special interest group, for example. In many lead user projects, broadcasting has been combined with pyramiding (Hienerth et al. 2007). Broadcasting can provide starting points for pyramiding, but sometimes also analogous fields can be found.

Based on our joint research, Mäkinen (2010) presented an integrated approach that combines the strengths of pyramiding, broadcasting, and screening. The approach takes fields provided by Participatory 3D modeling (P3D) as a starting point. P3D is a method for capturing user's and designer's perspectives of an existing product or service concept (see **Publication IV**, Helminen et al. 2010). Mäkinen shows that through broadcasting both solutions and persons can be found, and that both can be starting points for pyramiding, or in the best case, lead users outright. Behind a superior solution, there is always a person. This means that solutions can also be part of the pyramiding chain that ultimately guides to lead users. The integrated approach is presented in Figure 8.

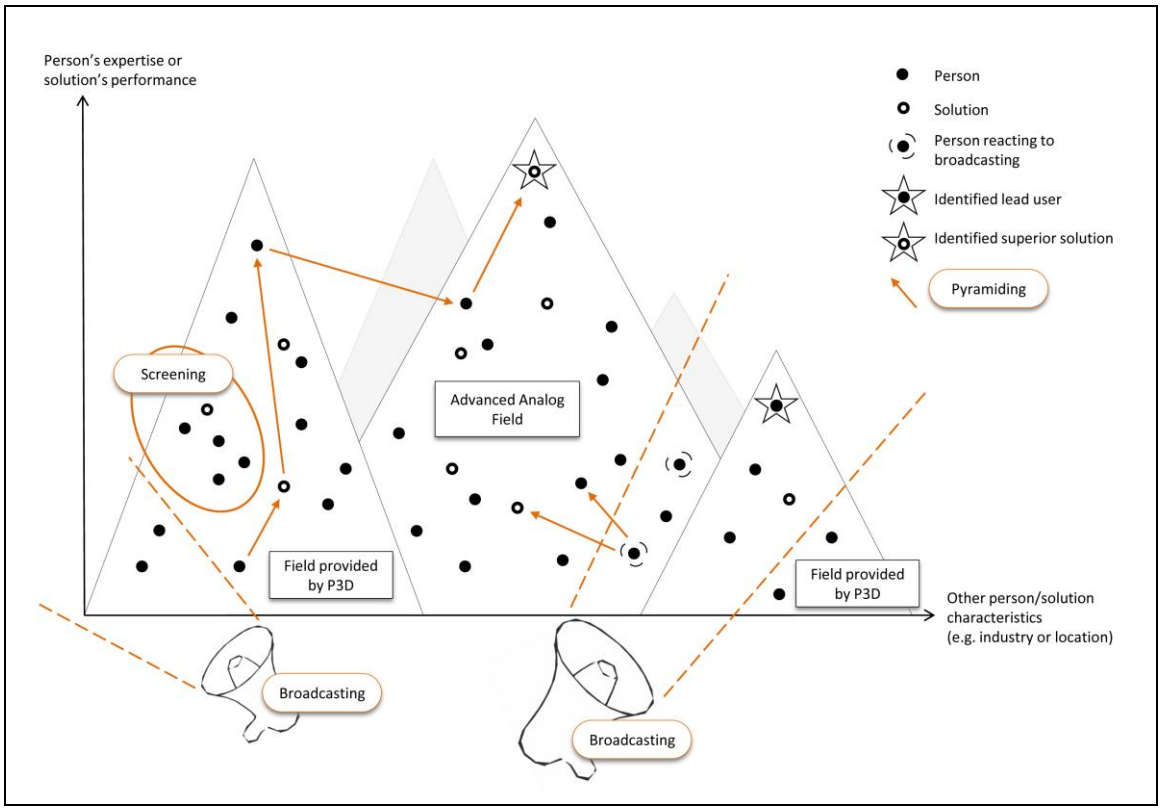

Figure 8 The integrated approach for lead user identification (Mäkinen 2010)

In **Publication III** (Tuulenmäki & Helminen 2009) the identification of lead users is discussed and two new concepts to aid the identification process are introduced: *situational* land *positional lead users* (see Figure 9). The publication presents a framework that provides means of determining "the field" and "analogous fields", and eventually makes it easier to find potential lead users.

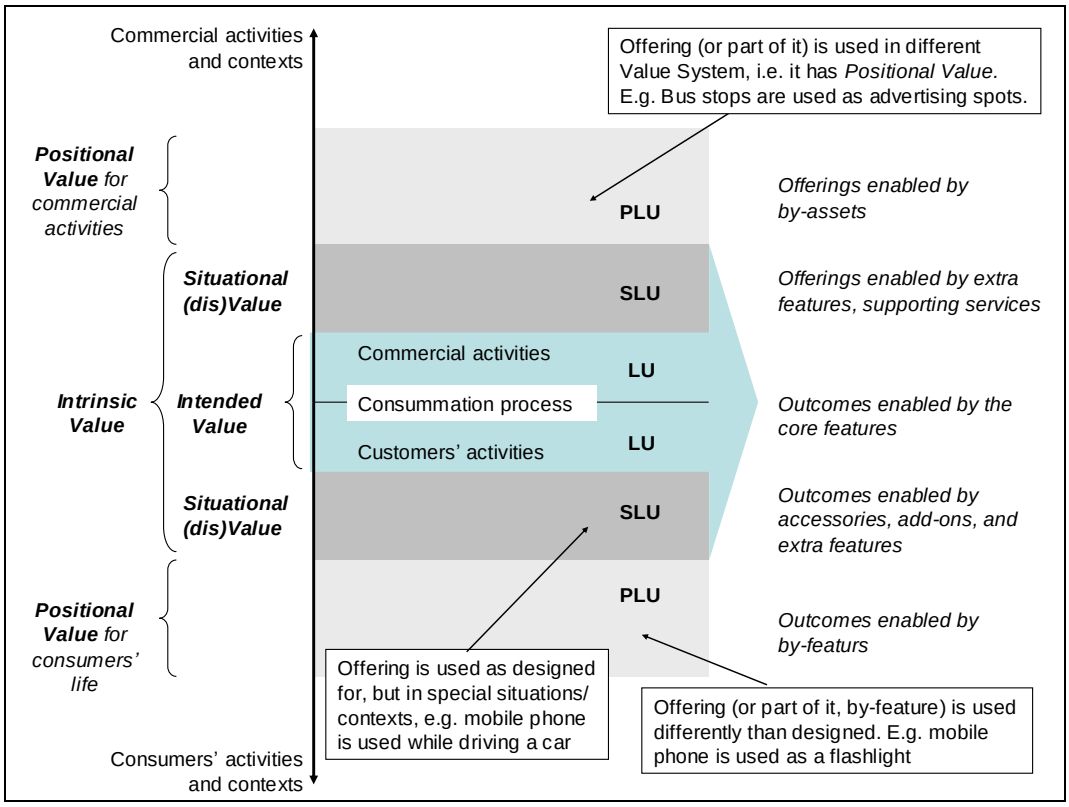

Figure 9 Lead Users (LU), Situational Lead Users (SLU), and Positional Lead Users (PLU) in relation to consummation process, Publication III (Tuulenmäki & Helminen 2009)

2.5 User Innovation Toolkits

Traditionally, users are seen as a source of need-related information, which the suppliers then turn into a responsive product. Monopolizing the product development in the supplier-side means costly and often time-consuming iterations between supplier and customer, in order to reach a solution that satisfies both ends. If the supplier can identify users that can act as innovators, i.e. sources of possible solutions and not only as a source of information, the supplier can skip the costly cycle of multiple iterations. One of the ways a supplier can try to accomplish this is by providing the users with tools so that they can design and develop the application specific part of a product on their own. (Thomke & von Hippel 2002; von Hippel & Katz 2002)

Users are specialists, when it comes to using the product. They possess information on what they want to do with the product, how, where and when, whereas manufacturers are familiar with manufacturing methods and technologies critical for the product to be able to function. The supplier-side spends a significant amount of resources trying to understand user needs.

Multiple methods for exploring the user needs exist varying from market research methodology to ethnography, and everything in between. Hence, transferring the need-related information from the user-side to the manufacturer requires time and money.

When information is costly to transfer from a locus to another, it is called "sticky". The stickiness occurs when acquiring the information requires a set of certain tools, education, or complementary information. Cohen and Levinthal (1990) call this lack of "absorptive capacity". The stickiness of a given unit of information in a given instance is defined as the incremental expenditure required to transfer it to a specified locus in a form that can be used by a given information seeker. When this cost is low, information stickiness is low; when it is high, stickiness is high (von Hippel 1994).

Successful product development requires transferring the need-related information of the user and the solution-related information of the manufacturer to a single locus. If transferring the need-related information from the user to the manufacturer is costly, why not try to do the opposite? How? In addition to more daring solutions such as the producer joining an existing user innovation community (von Hippel 2005; Heiskanen et al. 2010), so called user innovation toolkits are proposed (von Hippel 2001; von Hippel & Katz 2002). In this approach, users are seen as sources of possible solutions, not only need-related information. But in order to help users carry out the innovation task, they need to be equipped with toolkits containing relevant solution-related information.

The user innovation toolkit divides the design task into subtasks. In principle, the need-related design tasks are assigned to users and solution-related tasks are assigned to manufacturers. For example, the travel industry has invested in "unsticking" its solution-related information – airline schedules, hotel reservations, car rentals – by providing the users with possibilities to create their own solutions online. As a rule of thumb: the higher the heterogeneity of user needs faced by a manufacturer, the higher its incentive to invest in unsticking problem-related information relevant to user problem solvers and transfer that information to users in the form of a toolkit for user innovation (von Hippel 1998; von Hippel & Katz 2002).

Von Hippel and Katz (2002) propose that a well-designed user innovation toolkit should consist of five elements. It should enable the user to create solutions through an iterative *trial-and-error process*. The possible *solution space* should be narrowed down to such solutions that are possible for the manufacturer to produce. The toolkit should be "*user friendly*" in the sense that users do not need to engage in much additional training to use them. Users should be able to operate the toolkit with their customary *design language and skills*. There should be a *module library* included in the toolkit, consisting of commonly used modules that the user can incorporate into his or her custom design. This will prevent the

user from having to ”re-invent the wheel”, and allow the user to focus his or her design efforts on the truly unique elements of that design. Most importantly, the toolkit must enable fluent communication between the user and the manufacturer, i.e. “*speak the same language*”. This means ensuring that products and services designed by users with the help of the toolkit will be producible on manufacturer production equipment without requiring revisions by manufacturer-based engineers. (von Hippel & Katz 2002; von Hippel 2001)

An example of a successful user innovation toolkit is the case of Nestle USA’s Food Services Division toolkit test project (von Hippel & Katz 2002). Production of custom food products such as custom Mexican sauces for major restaurant chains is a major business for Nestle. This type of custom foods have been traditionally developed by or modified by chain executive chefs, using food ingredients available to individuals and restaurants, processed on restaurant-style professional equipment. The problem here is the case of “translating” a recipe expressed in the “language” of a traditional restaurant-style culinary toolkit into the “language” required by a food manufacturing facility. Food factories can only use ingredients that are obtainable in quantity at a consistent quality, which means ingredients that are not the same as and may not taste quite the same as ingredients used by the executive chef during recipe development. Food factories also use volume production equipment that is very different from restaurant-style stoves and pots and pans. Therefore, food production factories cannot simply produce a recipe developed by or modified by an executive chef “as is” under factory conditions – it will simply not taste the same. The production chefs’ solution at the food factory is to examine and taste the customer’s custom food prototype, and then try to make something that “tastes the same” using factory ingredients and methods. In the case of Nestle, this iterative “translation” effort means that it often takes 26 weeks to bring a new custom food product from chef’s prototype to first factory production.

To solve the translation problem, a user innovation toolkit of food “pre-component” ingredients was developed to be used by executive chefs during food development. Each ingredient in the toolkit is the Nestle factory version of an ingredient traditionally used by chefs during recipe development. For example, a toolkit designed for Mexican chefs contains a chili puree ingredient processed on industrial equipment identical to that used to produce food in commercial-sized lots. Chefs using the toolkit of Nestle pre-components to develop new product prototypes do find that each component differs slightly from the fresh components, but these differences are discovered immediately via “learning by doing,” and the chef then can adapt and move to the desired final taste and texture by making trial-and-error adjustments. Once a recipe based on pre-components is finished, it will only be multiplied to meet the factory magnitude and then be immediately and precisely reproduced by Nestle factories. This is possible because now the user-developer is using the same language as the factory for his or her design work. In the Nestle case, the “error

free translation" toolkit can potentially shorten the time of custom food development from 26 weeks to 3 weeks by eliminating repeated redesign and refinement interactions between Nestle and its custom food customers. (von Hippel & Katz 2002)

Publication V (Helminen & Ainoa 2009) examines, through an experiment on shopping center design, the roles of the size of the available solution space and the content of the module library. It is shown that contrary to assumptions, opening up either the solution space or the module library only will not lead users to communicate their true individual needs. Only when both elements are opened to a significant degree, the sticky need-related information will transfer.

Related to the toolkit approach, other approaches can be found in the literature, such as the "design game" that is part of the participatory innovation process introduced by Buur and Matthews (2008) or the "mock-up approach" by Ehn and Kyng (1991).

In attempt to further the toolkit approaches we developed the Participatory 3D modeling (P3D) method (**Publication IV**, Helminen et al. 2010) that was used for capturing user's and designer's perspectives of an existing product or service concept.

2.6 Positioning of the Thesis

In sum, firstly the lead user method is presented in the literature as a straightforward process (e.g. Urban & von Hippel 1988; Churchill et al. 2009) where not enough attention is paid to the crucial step of lead user identification. Literature suggests methods like screening, broadcasting, snowballing, pyramiding, and their combinations (e.g. Sudman 1985; von Hippel et al. 2009; Jeppesen & Lakhani 2010) that might guide to lead users in the targeted or advanced analogous field. **Publications I**, **II**, and **III** examine this challenge and bring new ways of thinking to the table by improving concepts and means available for lead user identification.

Secondly, after the suitable users have been identified, the problem remains how to transfer this sticky user knowledge to the company. User innovation toolkits (e.g. von Hippel & Katz 2002) are proposed as a solution. However, creating a toolkit can be a significant investment, and until it is being used, there is no guarantee it will generate a favorable outcome. **Publication V** investigates through an experimental setup the optimum composition of a user innovation toolkit. **Publication IV** combines the toolkit and participatory design approaches and introduces a method for capturing designers' and users' views on a product or service.

3 Summary of Publications

Publication I: Identifying Customer Needs – Disabled Persons as Lead Users

The purpose of this study was to investigate the identification of lead users, specifically, if so called "extraordinary" users could be used as lead users. Extraordinary users experience needs more often and in a larger scale than "ordinary" users – marathon runners vs. casual joggers, for example. In this study the user needs of disabled and "situationally disabled" mobile phone users were compared.

Traditionally, mainstream consumer product design has not explicitly considered the needs of disabled people. Yet in many ordinary circumstances we all suffer from a "situational disability". When there is no light, we cannot use our eyesight, for example. When there is a lot of noise, we are not able to hear. The examined user groups in this study were deaf, blind, and ordinary users, who see and hear well. A two-part goal was set:

(A) to find out if the needs of extraordinary users (disabled users in this example) are in fact the same as those that ordinary users face situationally; and
(B) to investigate if the extraordinary users also experience today what the target market may experience later, i.e. if they in fact do "live in the future" and thus are lead users and a valuable resource in customer need identification.

What was found is that the user needs of ordinary users in special situations (situationally disabled) correspond well to the needs of the extraordinary (disabled) users in ordinary situations. The disabled persons were found to experience needs that ordinary users may experience later. Also several examples of solutions already obtained by disabled persons were shown. When the data gathered through this study is looked at in reference to von Hippel's definition of lead users, it is found that the second lead user characteristic clearly applies to disabled users: Disabled users surely benefit significantly by obtaining a solution to their needs. What comes to the first characteristic, there are examples that show that the extraordinary users driven by their extraordinary needs have found solutions, like text messages amongst the deaf community that have later become common among all users. There seems to be a similar trend in two-way video calling. This suggests, that in order to accelerate the adaptation of the new application, companies could investigate the needs of extraordinary users who already use various mobile two-way video communicating applications, and use the information to develop the new mobile phones (or other devices) to better match the (latent) needs of the public.

Publication II: Disabled Persons as Lead Users for Silver Market Customers

Publication II extends the idea of disabled users as lead users, examining in particular the case of the expanding silver market. The motivation of this article was that the customers of the so-called silver market have not yet been considered as a valuable market for new products. The silver market refers to the aging population of industrialized countries, who are often beginning to suffer from deterioration in their eyesight, hearing, or mobility. The target market of most of the products, such as mobile phones, being virtually all consumers, means that the aging population should not be shrugged aside, as it continues to fill an ever-increasing part of the target market.

To be able to satisfy the needs of a market where user needs have become increasingly heterogeneous, concepts like *universal design* (USA and Japan), *design for all* (Europe), and *inclusive design* (UK) have been developed. In addition, more labeling concepts such as *design for disability* have come up. These concepts fall under the umbrella of user-centered design, where the user needs are indeed considered but where the designer of the solution is mostly the engineer. The lead user approach, in contrast, sees lead users as a source of possible solutions.

This study shows that disabled users can be seen as lead users when developing products – in this case mobile phone user interfaces – for the silver market. It is known that in general the targeted customers are seldom able to articulate the latent needs behind their functional fixedness. For an aging silver market customer, this can be even more so, because deteriorating eyesight, for example, might be a delicate matter for them. Therefore it is possible that they are less willing to expose their actual, everyday needs, when approached by a designer. This suggests that it is especially important that lead users are utilized when developing products for the silver market customers.

Publication III: Lead Users of Positional Value

The goal of this article was to develop a framework for better identification of lead users. In the literature, methods like pyramiding are suggested as a way to navigate from the target field to analogous fields, where the ultimate lead users can be found.

Through illustrative real world cases, the publication explains the complex of "*intrinsic"* (Normann 2001), *situational*, and *positional value* of a certain offering in a consummation process, and shows that typically the term lead user (LU) refers to lead users of intrinsic value (whether or not there is an actual product yet available). "Intrinsic" value means the value that is released when the offering is used as intended: A mobile phone has value as a mobile phone, when one uses it for communication between spatially distributed people. When the phone is used in complete darkness or when driving a car, it still has "intrinsic" value, but the context of use is no longer in the intended value zone, but in a situational (dis)value zone. As is explained in **Publication I**, disabled users can be seen as lead users of this situational value. In this publication these users are termed *situational lead users (SLU)*.

Besides "intrinsic" value, offerings tend to also have other type of value in another value system, or another consummation chain. When the illuminated screen of a mobile phone is used as a flash light, the outcome – to be able to open a door with a key in darkness, for example – is enabled by not the intended features of the product, but by so called by-features. The value that the offering positioned in another value system has, can be termed *positional value* in the publication. Therefore, it is proposed that users who fulfill their needs with by-features of a product are called *positional lead users* (PLU).

Nowadays, there are mobile phones with integrated flashlights (and also separate small flashlights that can be attached to a mobile phone) available on the market. It is hard to say how companies ended up with the idea of integrating a flashlight into their phones, but in retrospect one can say that the companies could have found the idea through examining positional lead users. This is analogous to the traditional lead user theory, which suggests that companies can benefit from lead user innovations.

In this work, the authors propose a framework which

1) provides systematic means of determining "the field" and "analogous fields", and eventually
2) makes it easier to find potential lead users.

Publication IV: Redefining User Perception – A Method for Fully Capturing the User Perspective of a Product Concept

The purpose of this study was to develop and test a method – Participatory 3D modeling (P3D) – for capturing user's and designer's perspectives of an existing product or service concept.

In current industrial practice, it is understood that the needs and expected benefits of a customer (user) have to be translated into functional features and requirements in the product and many methods for translating the customer needs into engineering requirements and specifications exist. Designers' and users' perceptions of a product have been studied, but the research has concentrated on product form, aesthetics and visual references. In this study the term "perception" is defined as an extended user perspective of a product, which describes how the users actually conceive and experience a product before, during, and after its use.

The aim of P3D is to discover all the elements of a specific product or service and, out of those elements, form groups to represent the main areas of the product. The method is based on the participants' knowledge of the product under examination. The participants build a model, in 3D, of their perception of the product using given materials and then disassemble the newly built model in a structured way revealing and identifying all the elements which together form that specific product concept. A complete P3D workshop consists of five main phases each of them including several steps. Those phases are called: preparation, warm-up, model building, disassembling, and grouping.

In this study, the Participatory 3D modeling method was applied in order to learn how an online media application Opettaja.tv is perceived by its users and designers. Two separate workshops were organized: one for the users and one for the designers.

Our original assumption was that the designers' perception is based on individual features of the product, "the idea-in" (Hansen & Andreasen 2002), whereas the user perception would concentrate on corresponding incidents related to the use value and context of the product, "the idea-with" (Hansen & Andreasen 2002). However, once we tested the P3D method, we saw that users in fact ended up modeling something more. Instead of concentrating on the product itself, the users ended up modeling a coherent whole – their overall experience relating to the product concept. The designer sees the concept as something that could be produced while the user sees it as something that could be used or consumed.

Publication V: User Innovation Toolkits in Product Development: Qualitative Study in Shopping Center Design

The goal of this study was to experiment how changes in the elements of a user innovation toolkit affect the outcome. The case at hand was to design a dream solution for a shopping center. User innovation toolkits are designed to help so called "sticky information" transfer more easily from user to the manufacturer.

According to the literature, a well-designed toolkit consists of five elements: it provides an *iterative trial-and-error process*, the possible *solution space* is narrowed down to such solutions that are possible for the manufacturer to produce, it is *"user friendly"* in the sense that users do not need to engage in much additional training to use them, there is a *module library* included in the toolkit, consisting of commonly used modules that the user can incorporate into his or her custom design, and, most importantly, the toolkit enables fluent communication between the user and the manufacturer, i.e. *"speaks the same language"*.

The purpose of this study was to investigate what effect altering the solution space and the module library has on the outcome. The authors wanted to learn how users behave when offered an unlimited solution space and/or a module library consisting of both typical shopping-related modules and special modules.

After an initial pilot study, 3 different versions of the toolkit were experimented on 5 women each in the age group of 30–40. The first toolkit had a typical module library but unlimited solution space. In the second toolkit, the solution space was limited, but the user had access to an extended module library. The third toolkit provided the user with both unlimited solution space and an extended module library.

The experiment showed that contrary to assumptions, opening up either the solution space or the module library only, did not lead users to communicate their true individual needs. Only when both elements were opened to a significant degree, the sticky need-related information transferred.

4 Summary of Results

In Chapter 1.2, two objectives were defined for this thesis. The specific aims were set

(A) *to further improve the concepts and means available for lead user identification*, and

(B) *to gain more understanding and alternative means for transferring (lead) user knowledge*.

Objective (A) has been treated especially in Chapters 2.3 and 2.4, and in **Publications I**, **II** and **III**. Many examples from the literature show that users, who experience new needs before these needs become general in the marketplace and who would greatly benefit if these needs were met, are "loaded with potential" to generate innovations that substantially differ from existing market offerings. These users are called lead users. It is notable, however, that examples concentrate on lead users of especially high performance level: marathon runners being lead users for casual joggers, or aerospace industry being a lead user industry from car manufacturer's standpoint, for example. **Publications I** and **II** show that for efficient lead user identification, also *low-performance users* should be considered. Both publications explore the value of disabled users in mobile phone design. **Publication II** concentrates particularly in the so called silver market, which is an expanding and for the time being still under-explored market in the western world.

There are several, but fairly similar, versions of the lead user method available in the literature. The weakest point of the method is when lead users should be identified on a certain field (or advanced analogous fields), or in the leading edge of a certain trend. Screening, snowballing, pyramiding, and broadcasting – and their combinations – are offered as ways to identify lead users. In **Publication III** a framework for better identification of lead users is proposed. The framework provides means of determining "the field" and "analogous fields", and eventually makes it easier to find potential lead users. Through explanatory real world cases, complementing concepts of *situational value & situational lead user* and *positional value & positional lead user* are developed. Also the concepts of *"intrinsic" value* and *intended value* are explained.

Lead users are traditionally understood to be lead users tied to the intended value of a class of products, even as their needs are not fully met by the designed-in characteristics of the products available in the market. If a surgeon develops a better tool for the operating room, for example, he is a typical lead user (LU). When the phone is used in complete darkness or when driving a car, it still has "intrinsic" value, but the context of use is no longer in the intended value zone, but in a situational (dis)value zone. Operating properly in a situational (dis)value zone often requires accessories, add-ons or other extra features on

top of the core features. When a blind person develops a solution that would help a user with full vision to better use the mobile phone in darkness, the blind person is a situational lead user (SLU).

Positional value is like a by-product of the intended value. Utilizing positional value dimensions usually requires utilizing by-features or by-assets. Therefore it is proposed that there must be lead users of positional value, analogous to lead users of "intrinsic" value and situational value. Accordingly, positional lead users (PLU) refers to people/companies who fulfill their needs with by-features of artifacts or assets originally intended for something-else.

Publication III presents, how the proposed framework can be used for systematic identification of lead users by analyzing the core features, outcomes, situations when users are momentarily disabled, and the by-features of a product.

Objective (B) was to gain more understanding and alternative means for transferring (lead) user knowledge. It has been treated especially in Chapter 2.5, and in **Publications IV** and **V**. **Publication IV** recapitulates the well rehearsed fact that the worlds of the designer and the user are fundamentally different. The designer sees a product concept as something that could be produced while the user sees it as something that could be used or consumed (Engeström & Escalante 1996; Hyysalo 2009; Hyysalo 2010). While this is something known widely and for long, there is a notable lack of means by which to demonstrate how exactly do developers' and users' perceptions of a product differ, particularly when it comes to complex informational products such as many software applications, whose characteristics are notoriously difficult to observe, or services that are intangible and abstract by nature. In this publication a method called Participatory 3D modeling (P3D) was developed and tested on users and designers of an online media application Opettaja.tv. The experiment revealed that the users were not able to see the product apart from the context where it was used. Instead of concentrating on the product itself, the users ended up modeling their overall experience relating to the product concept. This confirms the notion in the literature that users are specialists, when it comes to using the product, and that they possess information on what they want to do with the product, how, where and when, whereas manufacturers are familiar with manufacturing methods and technologies critical for the product to be able to function.

P3D proved to be an effective method for transferring user knowledge of an existing product concept. The next natural step would be to see it as a design tool that could be used to transfer user knowledge in the front-end.

The goal of **Publication V** was to experiment how changes in the elements of a user innovation toolkit affect the outcome. The general assumption is that the

solution space must be limited, in order to prevent users from developing a solution that the manufacture cannot manufacture. On the other hand, it is assumed that users make use of the offered solution space and that toolkits that offer a large solution space allow substantial innovations. The role of a module library is to provide users with existing modules, so that they do not need to start designing from scratch. The purpose of this publication was to learn how users behave when offered an unlimited solution space and/or a module library consisting of both typical and special modules. This was experimented with three different toolkits.

The experiment showed that contrary to assumptions, opening up either the solution space or the module library only, did not lead users to communicate their true individual needs. In the case of Toolkit 1, the module library was limited to typical modules, but the solution space was unlimited. The result was that either the unlimited solution space was not utilized at all, or if it was, it was used only for adding more typical modules into to the design. In Toolkit 2, the solution space was limited, but the module library was extended to contain untypical modules. Yet only few untypical modules were used in the designs, and even then, not the ones from the radical end of the available range of modules. It was only in the case of Toolkit 3, when the solution space was unlimited and the module library simultaneously extended, where users really started designing their own dream solution. The conclusion was that only when both elements – the solution space and the module library – were opened to a great degree, the need-related user knowledge gets adequately transferred.

5 Discussion and Conclusions

Understanding user needs is essential for companies to thrive in today's competitive environment. But how are user needs identified? And are these the needs of the right users? For long, designers and engineers have monopolized the development of new products. Nowadays, lead users have been recognized as users that are loaded with potential to generate novel solutions for needs that are not yet common among the masses.

Lead users face needs months or years before they become general in the marketplace. Lead users are also positioned to benefit significantly, if these needs are met. A lead user can be an actual user, like the one biker who thought first it would be a good idea to ride a bicycle down a mountain and started fixing his equipment accordingly. It could be a group of users, such as blind or deaf mobile phone users. A lead user can also be an entirely different field of industry, as were the military aircrafts in the case of the antilock braking systems commonly used in cars.

The challenge of the companies is not only to open up to the possibility that a competitive solution might be developed *outside the company*, but that it could be developed to meet a need that is identified *outside the target market* of the product under development.

If companies concentrate solely on the needs of the users in the target market, they very possibly miss insights from the lead users. In **Publications I** and **II** it was shown that not only the high-performance users but also the low-performance users can be seen as lead users. It is important not to draw too strong parallels between this and the Universal design approach (as termed in the US, Design for all as termed in Europe). The philosophy of the latter is that when products and environments are developed for the disabled, they may also serve the able-bodied. The idea behind the low performance lead users is that the product is still being developed for the large mass market, and not a niche, but that the low-performance lead users are likely to have already found solutions for the needs that will soon be faced among the masses. What is fundamentally different in these two cases is that when a product is being developed specifically for the disabled market, the end result very often stands out from the other offerings. If low-performance users (not necessarily just disabled users) are seen as lead users, this will boost the development of the products for the large target market, but as a "bonus" also produce products that the niche low-performance users will feel comfortable using as they are not stigmatizing.

Publication III proposes a framework that enables to see beyond the intended value of a product and the corresponding consummation chain. As **Publication IV** shows, a product is always part of a net of crossing consummation chains in the

user's life, and in user's point of view it cannot be seen as unconnected. Recognizing the inevitable crossing points of different consummation chains and value systems opens up for the possibility to identify not only *lead users* and *situational lead users*, but also *positional lead users*.

Since the standpoints of the designer and the user tend to be fundamentally different (**Publication IV**), it is crucial that the need-related (lead) user knowledge be transferred to the company. User innovation toolkits have been proposed as a tool for transferring this so called "sticky" information. **Publication V** suggests that both the module library and the solution space must be opened up, in order for the transfer of user's true individual needs to take place. This is in conflict with the thought that the solution space should be limited to cover only those solutions that the company is able to manufacture as implicated by, for instance, the Nestle Food Services Division case (p 29). Therefore although a solid idea on paper, creating functional and efficient user innovation toolkits might be too risky (or even impossible) a task in most product development cases.

In the light of this licentiate's thesis, it would be wiser for the companies to concentrate on lead user identification. Once the lead users have been found, two different cases can be identified: The lead user has already found a viable solution to his or her need, or the lead user is still battling with the unmet need. In the first case, the solution could be transferred as such (naturally some technical development might be needed inside the company). In the latter case, where the lead user is still searching for the solution, what is to be transferred is the user need. This can be done through many participatory methods available in the literature (see e.g. Bødker et al. 2004). Also the Participatory 3D modeling method (presented in **Publication IV**) when used as a design tool, can be used for transferring the needs of the user.

The goal of this research was *to explore the role of lead users in product development and advance the lead user methodology*. The conclusions include that first of all, companies need to recognize the fact that users do innovate, whether companies pay attention to it or not, and some of those users, lead users, are an important and viable source for both need and solution information for product development. There are lead users there waiting to be identified. What is needed is that the developers of new products dare to consider users outside the target market, and open up to the reality of crossing consummation chains where no product is used unconnected.

References

Adamson, R.E., 1952. Functional fixedness as related to problem solving; a repetition of three experiments. *Journal of Experimental Psychology*, 44, pp.288-291.

Beyer, H. & Holtzblatt, K., 1999. Contextual design. *Interactions*, 6(1), pp.32-42.

Beyer, H. & Holtzblatt, K., 1998. *Contextual design: defining customer-centered systems*, San Francisco: Morgan Kaufmann.

Brody, H., 1996. The web maestro: an interview with Tim Berners-Lee. *Technology Review*, 99(5), pp.32-40.

Buur, J. & Matthews, B., 2008. Participatory innovation. *International Journal of Innovation Management*, 12(3), pp.255-273.

Bødker, K., Kensing, F. & Simonsen, J., 2004. *Participatory IT design: Designing for business and workplace realities*, Cambridge, MA, USA: MIT Press.

Chesbrough, H.W., 2003. *Open innovation: The new imperative for creating and profiting from technology*, Boston, MA, USA: Harvard Business School Press.

Chesbrough, H.W., Vanhaverbeke, W. & West, J. eds., 2006. *Open innovation: Researching a new paradigm*, New York, NY, USA: Oxford University Press.

Churchill, J., von Hippel, E. & Sonnack, M., 2009. *Lead User Project Handbook: A practical guide for lead user project teams*, Available at: http://web.mit.edu/evhippel/www/Lead User Project Handbook %28Full Version%29.pdf.

Cohen, W.M. & Levinthal, D.A., 1990. Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly*, 35(1), pp.128-152.

Duncker, K., 1945. On problem-solving (Translated By Lees, L. S.). *Psychological monographs*, 58(5).

Ehn, P. & Kyng, M., 1991. Carboard computers: Mocking-it-up or hands-on the future. In J. Greenbaum & M. Kyng, eds. *Design at work: Cooperative design of computer systems*. New Jersey, USA: Lawrence Erlbaum Associates, Inc., pp. 169-195.

Engeström, Y. & Escalante, V., 1996. Mundane tool or object of affection? The rise and fall of the postal buddy. In B. A. Nardi, ed. *Context and consciousness: Activity theory and human–computer interaction*. Cambridge, MA, USA: MIT Press.

Franke, N. & Shah, S., 2003. How communities support innovative activities: an exploration of assistance and sharing among end-users. *Research Policy*, 32, pp.157-178.

Franke, N. & von Hippel, E., 2003. Satisfying heterogeneous user needs via innovation toolkits: the case of Apache security software. *Research Policy*, 32(7), pp.1199-1215.

Franke, N., von Hippel, E. & Schreier, M., 2006. Finding Commercially Attractive User Innovations: A Test of Lead-User Theory. *Journal of Product Innovation Management*, 23, pp.301-315.

Gaver, B., Dunne, T. & Pacenti, E., 1999. Cultural Probes. *Interactions*, 6(1), pp.21-29.

Goodman, L.A., 1961. Snowball Sampling. *The Annals of Mathematical Statistics*, 32(1), pp.148-170.

Hannukainen, P. & Hölttä-Otto, K., 2006. Identifying customer needs - Disabled persons as lead users. In *Proceedings of IDETC/CIE 2006*. September 10-13, Philadelphia, Pennsylvania, USA: ASME 2006 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference.

Hansen, C.T. & Andreasen, M.M., 2002. The content and nature of a design concept. In *Proceedings of NordDesign 2002*. Trondheim, Norway.

Heiskanen, E. et al., 2010. Constructing innovative users and user-inclusive innovation communities. *Technology Analysis & Strategic Management*, 22(4), pp.495-511.

Helminen, P., 2008. Disabled Persons as Lead Users for Silver Market Customers. In F. Kohlbacher & C. Herstatt, eds. *The Silver Market Phenomenon:Business Opportunities in an Era of Demographic Change*. Berlin Heidelberg: Springer-Verlag, pp. 85-102.

Helminen, P. & Ainoa, J., 2009. User innovation toolkits in product development: Qualitative study in shopping center design. In *Proceedings of ICED'09*. 24-27 August, Stanford, CA, USA.

Helminen, P., Hämäläinen, M.M. & Mäkinen, S., 2010. Redefining user perception - A method for fully capturing the user perspective of a product concept. In *Proceedings of IDETC/CIE 2010*. August 15-18, Montreal, Quebec, Canada: ASME 2010 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference.

Hienerth, C., Pötz, M. & von Hippel, E., 2007. Exploring key characteristics of lead user workshop participants: Who contributes best to the generation of truly novel solutions? In *Proceedings of DRUID Summer Conference*. June 18-20, Copenhagen, Denmark.

Hyysalo, S., 2010. *Health technology development and use: From practice-bound imagination to evolving impacts*, New York, NY, USA: Routledge.

Hyysalo, S., 2009. *Käyttäjä tuotekehityksessä: Tieto, tutkimus, menetelmät*, Helsinki, Finland: Taideteollinen korkeakoulu.

Jeppesen, L.B. & Lakhani, K.R., 2010. Marginality and Problem-Solving Effectiveness in Broadcast Search. *Organization Science*, 21(5), pp.1016-1033.

Ketola, P., 2002. *Integrating usability with concurrent engineering in mobile phone development*. Tampere, Finland: Tampereen yliopistopaino Oy.

Khurana, A. & Rosenthal, S.R., 1998. Towards holistic "front ends" in new product development. *Journal of Product Innovation Management*, 15(1), pp.57-74.

Koen, P. et al., 2001. Providing clarity and a common language to the "fuzzy front end". *Research-Technology Management*, 44(2), pp.46-55.

Lakhani, K.R., 2006. Broadcast search in problem solving: Attracting solutions from the periphery. *MIT Sloan School of Management working paper*.

Lilien, G.L. et al., 2002. Performance assessment of the lead user idea-generation process for new product development. *Management Science*, 48(8), pp.1042-1059.

Lüthje, C., 2004. Characteristics of innovating users in a consumer goods field: An empirical study of sport-related product consumers. *Technovation*, 24(9), pp.683-695.

Lüthje, C., 2003. Customers as co-inventors : An empirical analysis of the antecedents of customer-driven innovations in the field of medical equipment. In *Proceedings of the 32th EMAC Conference*. Glasgow.

Lüthje, C., 2000. *Kundenorientierung im Innovationsprozess: Eine Untersuchung der Kunden-Hersteller-Interaktion in Konsumgütermärkten*, Wiesbaden: Gabler.

Lüthje, C. & Herstatt, C., 2004. The lead user method: an outline of empirical findings and issues for future research. *R&D Management*, 34(5), pp.553-568.

Lüthje, C., Herstatt, C. & von Hippel, E., 2005. User-innovators and "local" information: The case of mountain biking. *Research Policy*, 34, pp.951-965.

Morrison, P.D., Roberts, J.H. & von Hippel, E., 2000. Determinants of user innovation and innovation sharing in a local market. *Management Science*, 46(12), pp.1513-1527.

Mäkinen, S., 2010. *Groundwork for Developing and Implementing the Lead User Method for Redesigning a Media Based Teaching and Learning Service*. Espoo, Finland: Aalto University School of Science and Technology.

Normann, R., 2001. *Reframing Business: When the map changes the landscape*, Chichester: Wiley.

Otto, K.N. & Wood, K.L., 2001. *Product design: Techniques in reverse engineering and new product development*, Upper Saddle River, NJ, USA: Prentice Hall.

Rogers, E.M., 1962. *Diffusion of innovations*, New York, NY, USA: Free Press.

Rogers, E.M., 1995. *Diffusion of innovations* 4th ed., New York, NY, USA: Free Press.

Rogers, E.M. & Shoemaker, F., 1971. *Communication of innovations: A cross-cultural approach*, New York, NY, USA: Free Press.

Shah, S., 2000. Sources and Patterns of Innovation in a Consumer Products Field: Innovations in Sporting Equipment. *MIT Sloan Working Paper #4105*.

Smith, A., 1776. *Wealth of Nations*, ElecBook. Available at: http://site.ebrary.com/lib/aalto/docDetail.action?docID=2001574.

Smith, P.G. & Reinertsen, D.G., 1991. *Developing Products in Half the Time*, New York, NY, USA: Van Nostrand Reinhold.

Sudman, S., 1985. Efficient Screening Methods for the Sampling of Geographically Clustered Special Populations. *Journal of Marketing Research*, 22(1), pp.20-29.

Thomke, S. & von Hippel, E., 2002. Customers as Innovators: A New Way to Create Value. *Harvard Business Review*, 80(4), pp.74-81.

Tilastokeskus, 2009. *Televiestintä 2008*, Official Statistics of Finland. Available at: http://www.stat.fi/til/tvie/2008/tvie_2008_2009-06-09_fi.pdf.

Tuulenmäki, A. & Helminen, P., 2009. Lead users of positional value. In *Proceedings of 8th European Academy of Design Conference*. 1-3 April, Aberdeen, Scotland, pp. 453-458.

Ulrich, K.T. & Eppinger, S.D., 2008. *Product Design and Development* Fourth Edi., Singapore: McGraw-Hill.

Urban, G.L. & von Hippel, E., 1988. Lead User Analyses for the Development of New Industrial Products. *Management Science*, 34(5), pp.569-582.

von Hippel, E., 1994. "Sticky information" and the locus of problem solving: Implications for innovation. *Management Science*, 40(4), pp.429-40.

von Hippel, E., 2005. *Democratizing Innovation*, Cambridge, Massachusetts, USA: MIT Press.

von Hippel, E., 1998. Economics of Product Development by Users: The Impact of "Sticky" Local Information. *Management Science*, 44(5), pp.629-644.

von Hippel, E., 2007. Horizontal innovation networks - by and for users. *Industrial and Corporate Change*, 16(2), pp.293-315.

von Hippel, E., 1986. Lead Users: A Source of Novel Product Concepts. *Management Science*, 32(7), pp.791-805.

von Hippel, E., 2001. PERSPECTIVE: User toolkits for innovation. *Journal of Product Innovation Management*, 18(4), pp.247-257.

von Hippel, E., 1988. *The sources of innovation*, New York, NY, USA: Oxford University Press.

von Hippel, E., Franke, N. & Prügl, R., 2009. “Pyramiding: Efficient search for rare subjects.” *Research Policy*, 38(9), pp.1397-1406.

von Hippel, E. & Katz, R., 2002. Shifting Innovation to Users via Toolkits. *Management Science*, 48(7), pp.821-34.

von Hippel, E., Thomke, S. & Sonnack, M., 1999. Creating breakthroughs at 3M. *Harvard Business Review*, 77, pp.47-57.

Voss, A. et al. eds., 2009. *Configuring user-designer relations: Interdisciplinary perspectives*, London, UK: Springer.

Welch, S., 1975. Sampling by Referral in a Dispersed Population. *The Public Opinion Quarterly*, 39(2), pp.237-245.

Äijälä, E., 2007. *You Could Have It So Much Better. Matkapuhelimien personointi ja massaräätälöinti (Personification and Mass Tailoring of Mobile Phones)*. Helsinki, Finland: University of Arts and Design Helsinki.